STRUT SUSPENSION WITH PIVOTING ROCKER ARM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of the March 14, 2003 filing date of provisional patent application serial no. 60/454,829 which is incorporated by reference herein in its entirety.

FIELD OF THE INVENTION

[0002] The present invention relates to a strut suspension structure for an automotive vehicle to improve camber gain and roll center control, to provide variable caster control and progressive spring rates, while increasing shock piston velocities.

BACKGROUND OF THE INVENTION

[0003] The traditional McPherson strut is the most popular suspension on passenger cars today. However, the manufacturing and cost benefits of this setup result in reduced ride and handling performance. Various modifications have been proposed for strut suspension control systems, as evidenced by U.S. Patent No. 6,267,387; U.S. Patent No. 6,170,838; U.S. Patent No. 5,292,149; U.S. Patent No. 4,971,348; U.S. Patent No. 4,756,517; and U.S. Patent No. 4,236,728.

SUMMARY OF THE INVENTION

[0004] The improved strut suspension according to the present invention modifies the traditional McPherson strut suspension. The present invention improves camber gain and roll center control. The present invention provides variable caster control and progressive spring rates. The present invention also increases shock piston velocities. The improved strut suspension package according to the present invention can be bolted onto a performance or luxury version of a vehicle already equipped with a traditional strut suspension. The present invention draws the upper strut mount closer to the lower ball joint with respect to wheel movement.

[0005] The improved strut suspension according to the present invention includes a traditional strut architecture with the addition of an actuated upper strut mount or rocker arm, and a push rod. The push rod pivots the rocker arm to which the strut mount is attached. The pivoting of the rocker arm moves the upper strut mount both laterally and toward the lower ball joint. Both the pivot ratio and pivot locations can be optimized for improved handling (camber gain), improved ride characteristics (progressive strut displacement), or a balance in between. Rotating the rocker axis allows caster change and certain dive effects to be incorporated into the design. By actuating both ends of the strut, shock piston velocities are increased relative to wheel inputs allowing the damper to be more sensitive to the road profile. Strut displacement becomes mechanically progressive resulting in fewer natural

modes. Also, the upper strut mount can be designed to move longitudinally to effect caster trail and other parameters improving ride. Lateral movement of the upper strut mount improves the camber curve and changes the side view swing arm resulting in increased lateral stability of the roll center. In the "normal load" condition, the upper strut mount is designed in the same location of mounting on a vehicle without the push rod and rocker assembly. Since the basic suspension geometry is unchanged, the additional cost of the assembly does not need to be incurred in all vehicle models. Instead, the improved suspension can be bolted onto either performance or luxury models of the vehicle, or as a factory installed option. With multiple vehicles based on the same platform, the suspension option can be selectively included, excluded, or modified for various vehicle derivatives to achieve modularity. The improved strut suspension according to the present invention provides improvement in ride control, better cornering, and performance enhancing bolt on modularity.

[0006] Other applications of the present invention will become apparent to those skilled in the art when the following description of the best mode contemplated for practicing the invention is read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The description herein makes reference to the accompanying drawings wherein like reference numerals refer to like parts throughout the several views, and wherein:

[0008] Figure 1 is a simplified perspective view of an improved suspension strut according to the present invention;

[0009] Figure 2 is a front elevational view of the improved strut suspension according to the present invention;

[0010] Figure 3 is a front elevational view illustrating a "jounce" position of the improved suspension strut according to the present invention;

[0011] Figure 4 is a front elevational view showing a "rebound" position of the improved suspension strut according to the present invention; and

[0012] Figure 5 is a rear elevational view of the improved strut suspension according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0013] Referring now to Figures 1-5, an improved strut suspension 10 is illustrated. The strut suspension 10 includes a conventional shock absorber 12 including a reciprocal piston 14 within a cylinder 16 and spring 18 combination. The shock absorber assembly 12 is connected at a lower end to a steering knuckle 20. A wheel hub 22 is mounted on the steering knuckle 20 and rotatably supports the tire and rim assembly 24. The steering knuckle 20 also includes a lower ball joint 26

generally opposite from the connection of the lower end of the shock absorber assembly 12 to the steering knuckle 20. The lower ball joint 26 is connected to a transverse link 28.

[0014] The upper end of the shock absorber assembly 12 is connected to an upper strut mount or rocker arm 30. The upper portion of the shock absorber 12 is pivotally connected at 32 to one end of the rocker arm 30. The rocker arm 30 is pivotally supported at 34 to the automotive body or frame 36 shown in Figures 2-5. Opposite from the pivotal connection 32 on the rocker arm 30 is another pivotal connection 38. A push rod 40 is pivotally connected to the pivotal connection 38 of the rocker arm 30. The pivotal support 34 of the rocker arm 30 is generally positioned between the pivotal connection 32 and pivotal connection 38 of the rocker arm 30. The structural geometry of the rocker arm 30 can be modified as required for the particular application, as well as the orientation of the pivotal connections 32, 38 and pivotal support 34, as can be seen when comparing Figure 1 with Figure 5, where the rocker arm is shown with a slightly different structural geometry for the application illustrated in Figure 5 from that illustrated in Figures 1-4. In both configurations, one end of the push rod 40 is connected to the pivotal connection 38 of the rocker arm 30, while an opposite end of the push rod 40 is pivotally connected to the transverse link 28 at pivotal connection 42.

[0015] The improved strut suspension according to the present invention provides improved camber gain and roll center control. The strut suspension according to the present invention provides variable caster control and progressive spring rates, while increasing shock piston velocities. The strut suspension according to the present invention can be provided in a package capable of being bolted onto a performance or luxury version of a vehicle already equipped with a traditional strut suspension. The strut suspension according to the present invention draws the upper strut mount closer to the lower ball joint with respect to wheel movement, providing more effective damping than a traditional strut suspension.

[0016] In operation, the push rod 40 pivots the rocker arm 30 through pivotal connections 38, 42. Pivoting movement of the push rod 40 moves the rocker arm 30 and pivotal connection 32 connected to the upper portion of the shock absorber 12 and spring 18. The rocker arm 30 pivots about the pivotal support 34 in response to movement of the push rod 40. The motion of the push rod 40 and connected rocker arm 30 moves the pivotal connection 32 both laterally and towards the lower ball joint as illustrated in Figure 3. Both the pivot ratio and pivot locations can be optimized for improved handling (camber gain), improved ride characteristics (progressive strut displacement), or a balance in between camber gain and

progressive strut displacement. Rotating the rocker arm about the axis of the pivotal support 34 allows caster change and certain drive effects to be incorporated into the design. By actuating both ends of the strut, shock piston velocities are increased relative to wheel inputs allowing the damper to be more sensitive to the road profile. Strut displacement becomes mechanically progressive resulting in fewer natural modes. The upper strut mount to pivotal connection 32 of the rocker arm 30 can be provided with a particular structural geometry to move longitudinally to effect caster trail and other parameters improving ride. Lateral movement of the pivotal connection 32 of the rocker arm 30 improves the camber curve and changes the side view swing arm resulting in increased lateral stability of the roll center. In the normal load condition illustrated in Figures 1 and 2, the pivotal connection 32 of the rocker arm 30 is configured to be in the same location as when mounted in a vehicle without the push rod and rocker assembly. The basic suspension geometry is unchanged, and the additional cost of the assembly does not need to be incurred in all vehicle models. Instead, the improved suspension according to the present invention can be bolted onto either performance or luxury models of the vehicle, or as a factory installed option. With multiple vehicles based on the same platform, the suspension option can be selectively included, excluded, or modified for various vehicle derivatives to provide the desired modularity.

[0017] An improved strut suspension including a shock absorber and spring assembly mounted at one end to a steering knuckle and a transverse link connected to the steering knuckle opposite from the shock absorber and spring mount location, the improvement including a rocker arm supported for pivotal movement from the vehicle body and pivotally connected to an opposite end of the shock absorber and spring assembly, while pivotally connecting a push rod between the rocker arm and the transverse link. In one configuration, the upper portion of the shock absorber is connected to an outboard portion of the rocker arm, while the upper portion of the push rod is connected to the inboard portion of the rocker arm with respect to the center line of the vehicle. The lower portion of the shock absorber 12 is connected to an upper portion of the steering knuckle, while the lower portion of the push rod is connected to a lower portion of the steering knuckle through the transverse link. In another embodiment, the upper portion of the shock absorber is connected to an inboard portion of the rocker arm, while an upper portion of the push rod is connected to an outboard portion of the rocker arm with respect to the center line of the vehicle. The lower portion of the shock absorber is connected to the upper portion of the steering knuckle, while the lower portion of the push rod is connected to the lower portion of the steering knuckle through the transverse link.

[0018] While the invention has been described in connection with what is presently considered to be the most practical and preferred embodiment, it is to be understood that the invention is not to be limited to the disclosed embodiments but, on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims, which scope is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures as is permitted under the law.